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Rajinder Sahota
Deputy Executive Officer for Climate and Research
California Air Resources Board
1001 I Street – P.O. Box 2815
Sacramento, CA 95812

Subject: SoCalGas Comments on the February 25, 2025 Workshop on the SB 1075 Report

Dear Deputy Executive Officer Sahota:

SoCalGas appreciates the opportunity to comment on the California Air Resources Board's (CARB) February 25, 2025 Senate Bill (SB) 1075 Report Workshop. The comprehensive analysis provided by CARB and Energy and Environmental Economics (E3) projects hydrogen to be produced, transported, and used in multiple permutations across the industrial, transportation, commercial and residential sectors and become a crucial component of decarbonizing California's economy. Key points from the E3 presentation are:

- Pipelines will play a large role in the transportation of hydrogen through dedicated pipelines and hydrogen blending.
- The volumes of hydrogen production and distance between production and end use suggest pipelines may be the most cost-effective option of transport. The E3 presentation showed that the production sites of hydrogen are not co-located with the demand sites for hydrogen and therefore transportation will be critical.
- The majority of the hydrogen consumption will be in Southern California.
- E3 assumes aggressive hydrogen production costs drops with electrolytic hydrogen from Chinese electrolyzers as the most cost effective ($1 per kg), but other pathways like steam methane reformation (SMR), gasification, and pyrolysis could cost approximately $2 per kg by 2045.

- E3 assumes the electric grid is not carbon free by 2045. Thus, hydrogen production pathways that use biogenic fuels are assumed to have the lowest carbon intensity (CI).

With affordability being a priority for consumers and companies in pursuit of the State's decarbonization goals, policy solutions should consider the interconnected gas and electric system, leverage existing energy systems, and address hard-to-electrify end uses.

CARB and E3 are assessing new research and analysis of the emerging hydrogen sector in California. SoCalGas recently published 16 studies to evaluate the feasibility of Angeles Link, which is envisioned as a non-discriminatory, open access pipeline system dedicated to public use that could transport clean renewable hydrogen[1] from regional third-party production and storage sites to end users across Central and Southern California. In December 2022, the California Public Utilities Commission (CPUC) authorized SoCalGas to record costs relating to exploring and studying Angeles Link. That same decision recognized that "[Angeles Link] may bring public interest benefits to the state, and especially the Los Angeles area, because clean renewable hydrogen has the potential to decarbonize the state and the Los Angeles Basin's energy future."[2] The Angeles Link Phase 1 feasibility studies (ALP1 Studies) were developed over two years and published in December 2024. Spanning over 2,500 pages, the ALP1 Studies assess topics ranging from safety, production and demand, cost effectiveness, workforce development, GHG and air contaminant emissions, potential leakage, pipeline sizing, route design and configurations, and project alternatives.[3] The results of the studies establish that Angeles Link is technically feasible, viable, cost-effective, and could offer numerous public interest benefits.

Given the role the ALP1 Studies could play in helping CARB and E3 set a framework for their continued analysis, we welcome briefing CARB and E3 on the findings of these studies. SoCalGas appreciates CARB and E3's efforts to solicit public feedback in their development of the final SB 1075 analysis and report. SoCalGas provides the following answers to the nine questions posed by CARB and E3 at the workshop:

CARB Questions

1. *Please provide information on promising end uses for hydrogen that contribute to California's climate goals beyond those identified in the Scoping Plan.*

SoCalGas supports further analysis of hydrogen demand for power generation. While the 2022 Scoping Plan includes approximately 9 gigawatts (GW) of hydrogen power generation capacity,

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[1] Decision (D) 22-12-055 defines clean renewable hydrogen as "hydrogen that does not exceed a standard of four kilograms of carbon dioxide-equivalent produced on a lifecycle basis per kilogram of hydrogen produced." at p. 66 (Finding of Fact (FOF) 35).
[2] D.22-12-055, Decision Approving the Angeles Link Memorandum Account, CPUC, December 12, 2022, p.16, available at: https://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M500/K167/500167327.PDF.
[3] A consolidated report of the ALP1 Studies findings summarizes the results of the 16 studies. The consolidated report may be found at https://www.socalgas.com/sites/default/files/alproject/Angeles-Link-Phase-1-Consolidated-Report.pdf. All Angeles Link documents are available at: https://www.socalgas.com/regulatory/angeleslink.

various resource planning scenarios suggest many potential volumes of demand.[4] The California Energy Commission (CEC) states in the 2023 Integrated Energy Policy Report (IEPR) that 2045 hydrogen demand for the electric power sector may range from 350,000 to nearly 1.9 million metric tons based on a University of California, Irvine report and analysis of the 2022 Scoping Plan, respectively.[5] Hydrogen-fueled power generation could help maintain energy reliability and resiliency. Electricity demand may increase 76 percent by 2045[6] and the stress of heat waves on the grid may increase costs due to power outages. As California transitions to a cleaner decarbonized energy system, electric reliability and resiliency are expected to require clean "firm" power that can meet system and/or local demand under a wide variety of conditions. The economic impact of power outages is substantial, with estimated losses reaching up to $11 billion for a 24-hour outage in SoCalGas's service territory, and even higher under anticipated extreme weather conditions of the future.[7] Without strategic investments in firm clean energy resources, California faces growing risks of power interruptions, economic losses, and safety concerns, particularly for vulnerable communities.[8]

SoCalGas commends CARB's continued recognition of hydrogen blending into the gas system as a key tool to decarbonize existing natural gas infrastructure as part of their 2022 Scoping Plan. Since hydrogen gas is made up of carbon-free molecules, blending it with natural gas could make a significant contribution to lower carbon emissions in various sectors of the economy. For example, at a 20 percent hydrogen blend by volume, the typical carbon dioxide (CO_2) reduction potential of hydrogen is 6.3 percent.[9] That improvement would be equivalent to removing 1.52 million gasoline-powered passenger vehicles from the road or replacing about 6 percent of California's registered automobiles with zero emission vehicles.[10]

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[4] As SoCalGas has previously stated in written comments regarding CARB's 2022 Scoping Plan, robust industry-accepted reliability modeling approaches should be applied to scenario modeling. The SB 1075 analysis and scenarios, if any, should incorporate Loss of Load Expectation (LOLE) reliability assessments with a planning target of 0.1 days/year, or 1 day in 10 years, to ensure scenarios are reliable, and therefore feasible, while minimizing cost. LOLE studies address all 8,760 hours of the year and are thus able to assess the reliability contributions of all resource types including intermittent resources and use-limited resources. Modeling efforts that attempt to take short-cuts such as using only a Planning Reserve Margin (PRM), may provide a false sense of security. See comments on 2022 Scoping Plan Update – Electricity Sector Technical Workshop, SoCalGas & SDG&E, November 21, 2021, available at: https://www.arb.ca.gov/lists/com-attach/15-sp22-electricity-ws-VSYFZ1A2WG4EXQdm.pdf.

[5] Adopted 2023 Integrated Energy Policy Report with Errata, CEC, February 14, 2024, p. 78-80, available at: https://efiling.energy.ca.gov/GetDocument.aspx?tn=254463.

[6] 2022 Scoping Plan for Achieving Carbon Neutrality, CARB, November 2022, p. 202, available at: https://ww2.arb.ca.gov/sites/default/files/2022-11/2022-sp.pdf.

[7] Please see the testimony by Josh Schellenberg in support of the Angeles Link Phase 2 Application, Value of Electric Grid Reliability and Resilience, SoCalGas, December 20, 2024, p.13, available at: https://www.socalgas.com/sites/default/files/alproject/phase2/A.24-12-XXX_TestimonyCh.5-ValueofElecGridReliabilityandResilience_Schellenberg_PDFA.pdf.

[8] *Ibid*., Value of Electric Grid Reliability, p.29.

[9] Reduction of CO_2 Emissions by Adding Hydrogen to Natural Gas Report No. PH4/24, International Energy Agency (IEA), October 2003, available at: https://ieaghg.org/docs/General_Docs/Reports/Ph4-24%20Hydrogen%20in%20nat%20gas.pdf.

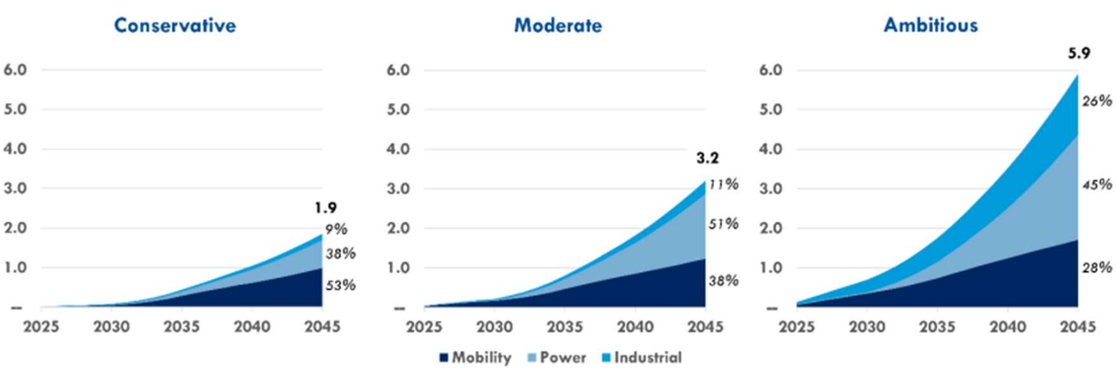
[10] Joint Amended Application of Southern California Gas Company, San Diego Gas & Electric Company, Pacific Gas & Electric Company, and Southwest Gas Corporation To Establish Hydrogen Blending Demonstration Projects; available at: https://www.socalgas.com/sites/default/files/2024-03/A.22-09-006JointAmendedApplicationforH2BlendingDemonstrationProjects.pdf.

2. *How do you expect the hydrogen supply and end use demand to change over the next decade?*

SoCalGas expects hydrogen supply and end use demand to grow over time as end users transition to decarbonized fuels. In its "LA100 Plan," the Los Angeles Department of Water and Power (LADWP) proposes to fully decarbonize the electric power sector by 2035. Preliminary modeling results of this study, performed for LADWP by National Renewable Energy Laboratory and Ascend Analytics, show that after running multiple alternatives (11 sensitivities in total), hydrogen is still a preferred solution for providing firm clean power in the LA Basin for reliability needs.[11]

More broadly, the ALP1 Demand Study forecasts the total hydrogen market potential through 2045 within SoCalGas's service territory under three different scenarios (see Figure 1 below). By 2035, the total market demand in SoCalGas's service territory is expected to grow up to 0.5 million metric tonnes per year (MMTPY) in the conservative scenario and up to 1.5 MMTPY in the ambitious scenario.[12]

Figure 1: Clean Renewable Hydrogen Demand Forecast in SoCalGas's Service Territory, by Scenario (2025-2045, values in Million TPY)[13]



The demand analysis did not consider the potential for blending, which was outside the scope of the ALP1 Demand Study. However, E3 indicates that one potential hydrogen demand end-use could be from blending up to a 7 percent energy limit into the gas distribution system. SoCalGas supports further analysis of this potential end-use, as blending hydrogen into the existing infrastructure combined with a utility procurement mandate would assist scaling up hydrogen production in the state and drive down costs in turn.

SoCalGas also emphasizes that blending beyond the distribution system is under consideration and should be factored into long-term hydrogen demand estimates. On March 1, 2024, SoCalGas, San Diego Gas and Electric (SDG&E), Pacific Gas and Electric (PG&E), and Southwest Gas (collectively, the Joint Utilities) submitted an amended application to the CPUC to perform hydrogen blending demonstration projects to help inform a safe injection standard for the

[11] The executive summary of the report may be found here: https://www.nrel.gov/docs/fy21osti/79444-ES.pdf
[12] Angeles Link Phase 1 Final Demand Study, SoCalGas, December 2024, available at: https://www.socalgas.com/sites/default/files/alproject/Angeles-Link-Phase-1-Final-Demand-Study.pdf.
[13] *Ibid., Angeles Link Final Demand Study*, p.8.

California natural gas pipeline system.[14] Within that application, PG&E's project proposes to demonstrate hydrogen blending from 5-20 percent on a transmission system.[15] The Joint Utilities' intent is for the PG&E project to inform, over a ten-year span, a potential blending standard for transmission systems in California.[16] Thus, blending into the transmission system may also occur in later years and should be considered for longer term demand in modeling.

3. *The SB 1075 Technology and State - level Assessments will evaluate environmental impacts including water consumption, land use, air quality, and safety associated with hydrogen production, distribution, storage, and end use. Can you suggest any specific metrics or analysis to consider when comparing impacts?*

The SB 1075 process could consider recently published evaluations or studies associated with dedicated hydrogen pipelines and blending. The ALP1 Studies provide a high-level assessment of potential environmental impacts as well as safety factors associated with dedicated hydrogen infrastructure.[17] These studies consider a variety of topics related to third party hydrogen production (e.g. water resources, land, etc.), potential emission reduction benefits (e.g. greenhouse gas (GHG) and oxides of nitrogen (NO_x)), and other desktop analysis related to environmental impacts and safety.

Third-Party Hydrogen Production Considerations

- **Water Resources Evaluation:** The ALP1 Water Resources Evaluation assessed the availability of water resources necessary for third-party clean renewable hydrogen production to support demand within SoCalGas's service territory and what could be conveyed by Angeles Link. The water required to produce a kilogram of hydrogen can range, depending on the production method, purity of the source water and configuration of equipment. The study found that the water required to meet the potential demand for clean renewable hydrogen production within SoCalGas's service territory represents a small fraction (approximately 0.02-0.10 percent) of California's annual water usage. Multiple existing water supplies, such as surface water, treated wastewater, groundwater, and urban stormwater capture, could be utilized, and new supplies could be developed if necessary.[18]

- **Production and Planning Study:** This Study evaluated potential sources of clean renewable hydrogen and identifies approximately 2 million acres of land potentially available for renewable energy development in three primary third-party production locations within the SoCalGas service territory. Production of the Angeles Link throughput

[14] A.22-09-006, Joint Amended Application of Southern California Gas Company, San Diego Gas & Electric, Company, Pacific Gas & Electric Company, and Southwest Gas Corporate to Establish Hydrogen Blending Demonstration Projects, available at: https://www.socalgas.com/sites/default/files/2024-03/A.22-09-006JointAmendedApplicationforH2BlendingDemonstrationProjects.pdf.
[15] *Ibid.*, A.22-09-006.
[16] *Ibid.*, A.22-09-006.
[17] Angeles Link Phase 1 Final Environmental Analysis, SoCalGas, December 2024, available at: https://www.socalgas.com/sites/default/files/alproject/Angeles-Link-Phase-1-Final-Environmental-Analysis.pdf.
[18] Angeles Link Phase 1 Final Water Resources Evaluation, SoCalGas, December 2024, available at: https://www.socalgas.com/sites/default/files/alproject/Angeles-Link-Phase-1-Final-Water-Resources-Evaluation.pdf.

case of 1.5 MMTPY of clean renewable hydrogen is estimated to require 240,000 acres (375 square miles), which represents approximately 12 percent of the land identified as potentially available for hydrogen production from all three production areas.[19]

Environmental Impact and Safety Considerations

- **The Greenhouse Gas (GHG) Emissions Evaluation and The NOx and Other Air Emissions Assessment Studies:** Angeles Link could support meaningful energy decarbonization and air quality benefits, including the potential reduction of 4.5 to 9 million metric tonnes of carbon dioxide equivalent (CO_2e) per year (the equivalent annual GHG emissions of removing approximately 725,000 to 1 million gasoline passenger vehicles off the roads per year), and up to 5,200 tons per year of NO_x emissions by 2045.[20]

- In accompanying testimony to the Angeles Link Phase 2 (ALP2) Application, Dr. Sonja Sax, a lead scientist in air quality at Epsilon Associates, describes how the reductions in exposure to pollutants estimated in the ALP1 Studies can have significant health benefits, particularly avoided premature mortality (mainly respiratory and cardiovascular mortality) from reduced particulate matter (PM) 2.5 and NO_x emissions, and that economic benefits associated with avoided premature mortality alone could range from approximately $183 million to $552 million (in 2018 dollars) per year by 2045—with the highest benefits accruing to DAC communities.[21]

- **The Evaluation of Applicable Safety Requirements:** The study includes a comprehensive safety evaluation and demonstrated that there are limited regulatory differences between hydrogen and natural gas pipeline transportation, and SoCalGas's expertise in natural gas pipeline construction, operation, and maintenance can be leveraged to safely design, construct, operate, and maintain a hydrogen pipeline system. The evaluation identified safety requirements ranging from material selection, pipeline design, fire protection strategies, leak detection, and monitoring programs to emergency response procedures and public awareness plans. It also considered lessons learned from prior industry and third-party experience with hydrogen. Fundamentally, the evaluation identifies SoCalGas's existing Safety Management System (SMS), which is consistent with American Petroleum Recommended Practice 1173 (API 1173) and inclusive of an Enterprise Risk Management model, as the necessary framework for managing safety holistically.[22]

4. *What methods for measuring and/or mitigating potential hydrogen leakage from production, distribution, storage, and end use should this report consider?*

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[19]Angeles Link Phase 1 Final Production Planning & Assessment, SoCalGas, December 2024, available at: Angeles-Link-Phase-1-Final-Production-Planning-&-Assessment.pdf.
[20] Angeles Link Phase 1 Studies Consolidated Report, SoCalGas, December 2024, p.15, available at: https://www.socalgas.com/sites/default/files/alproject/Angeles-Link-Phase-1-Consolidated-Report.pdf
[21] Prepared Testimony of Sonja N. Sax, ScD, SoCalGas, December 20, 2024, p. SS-2, available at: https://www.socalgas.com/sites/default/files/alproject/phase2/A.24-12-XXX_SoCalGasApplicationALP2_PDFA_2024.12.20.pdf.
[22] Angeles Link Phase 1 Evaluation of Applicable Safety Requirements, SoCalGas, December 2024, available at: https://www.socalgas.com/sites/default/files/alproject/Angeles-Link-Phase-1-Final-Evaluation-of-Applicable-Safety-Requirements.pdf.

SoCalGas suggests considering findings from the ALP1 *Hydrogen Leakage Assessment (December 2024)*.[23] This study evaluates the potential for hydrogen leakage associated with new hydrogen infrastructure (i.e., clean renewable hydrogen transportation and compression, third-party production, and third-party storage), and opportunities to minimize the potential for hydrogen leakage. The study collected, reviewed, and analyzed available technical literature and information from various sources including but not limited to academic institutions, private organizations, regulatory agencies, manufacturers working on monitoring technology (including sensors), and non-profits.

Leakage estimation methodologies discussed in the ALP1 Hydrogen Leakage Assessment include direct measurements, as well as wide-ranging estimation methodologies comprised of calculations via proxies such as natural gas, laboratory experiments, and theory-based models or simulations as discussed in studies evaluated in the literature. Mitigations and opportunities to minimize the potential for leakage from various processes are available in the design and engineering of new infrastructure, operation of equipment and systems, as well as maintenance procedures. In addition to design and engineering, the use of existing and emerging sensor technologies supports early identification of leaks and facilitates timely repairs, thereby mitigating potential leaks.

When considering hydrogen blending, California's Joint Utilities recently submitted the *Hydrogen Blending Compendium Report* to the CPUC.[24] This study assessed various leak detection methodologies currently used in natural gas infrastructure, including sensor-based technologies, odorization, and computational pipeline modeling. The report suggested that each of these methodologies could be suitable for detecting leakage of hydrogen/methane blends, but with varying degrees of accuracy or financial investment. Generally, sensor-based leak detection technologies used for natural gas infrastructure are noted to provide suitable detection with hydrogen/methane blends, particularly up to 20 percent hydrogen blends (by volume).[25] However, additional research is suggested to understand if sensor-based technology for pure hydrogen applications is suitable for detecting hydrogen/methane blends.[26] Odorization showed strong compatibility with hydrogen and hydrogen blends.[27] Computational pipeline modeling showed accurate leak detection, particularly when the hydrogen blend concentration is known.[28] From a mitigation perspective, the report showed that standard repair methods for natural gas leaks were equally effective for hydrogen blends.[29]

5. *What concerns do communities have regarding the production, distribution, storage, and end use of hydrogen?*

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[23] Angeles Link Phase 1 Hydrogen Leakage Assessment, SoCalGas, December 2024, available at: https://www.socalgas.com/sites/default/files/alproject/Angeles-Link-Phase-1-Final-Hydrogen-Leakage-Assessment.pdf.

[24] Notice of Filing of Joint Utilities' Hydrogen Blending Compendium Report, Joint Utilities, February 14, 2025, available at: https://docs.cpuc.ca.gov/PublishedDocs/Efile/G000/M556/K896/556896659.PDF.

[25] *Ibid.*, Hydrogen Blending Compendium Report, Chapter Summary, p.18.

[26] *Ibid.*, Hydrogen Blending Compendium Report, Literature Review, p.79.

[27] *Ibid.*, Hydrogen Blending Compendium Report, Chapter Summary, p.19.

[28] *Ibid.*, Hydrogen Blending Compendium Report, Chapter Summary, p.19.

[29] *Ibid.*, Hydrogen Blending Compendium Report, Chapter Summary, p.20.

SoCalGas created a comprehensive stakeholder engagement process during Phase 1 of Angeles Link in collaboration with the CPUC's Energy Division. In Phase 1, SoCalGas created two stakeholder groups: a Planning Advisory Group (PAG) and a Community Based Organization Stakeholder Group (CBOSG). The PAG was comprised of various organizations representing industry, academia, ratepayer advocates, government, and other interest groups. The CBOSG was created to engage organizations that are not typically involved in a project development planning process, including organizations who serve disadvantaged communities and environmental social justice interests. During the ALP1 stakeholder engagement process, the CBOSG identified potential concerns about the safety of communities living and working near hydrogen infrastructure, the environmental air quality impacts associated with the transportation and usage of hydrogen, and whether there would be direct workforce development opportunities for the communities living near the alignment. Specifically, CBOSG members called for transparency in pipeline safety standards, highlighting the need for education, training, and economic benefits, and reiterating direct benefits for disadvantaged communities. By the end of Phase 1, SoCalGas collectively held 27 meetings and workshops, as well as 32 one-on-one meetings with PAG and CBOSG members.[30]

E3 Questions

1. *If you are currently planning or developing a hydrogen project, can you please share specific cost sources that can be considered in the analysis?*

SoCalGas appreciates CARB and E3 for referencing Angeles Link as an important case study for pipeline transmission and compression infrastructure. SoCalGas points CARB and E3 to a few specific cost sources, including the ALP1 Studies, the Angeles Link Phase 2 (ALP2) Application and additional references included below in Q4 (see "Compendium of Hydrogen Studies").

As part of the ALP2 Application,[31] SoCalGas intends to advance Angeles Link to a 30 percent engineering design and includes the development of an Association for the Advancement of Cost Engineering (AACE) Class 3 cost estimate for approximately 450 miles of pipeline and compression. Advancing to ALP2 will enable more clarity of the specific cost estimates to develop the infrastructure necessary to connect producers to end-users.

SoCalGas agrees that transmission costs need to encompass distance, volumes, and various transportation methods to help determine appropriate delivery options. E3's pipeline transportation cost range of \$0.4-\$1.0 per kilogram (kg) hydrogen reflects the economics of pipelines when transporting large volumes (100-500 tonnes per day (TPD) over longer distances (up to 300 miles), which shows how pipelines are an effective and necessary transportation mode, especially as long-term hydrogen demand increases in a future decarbonized energy economy.

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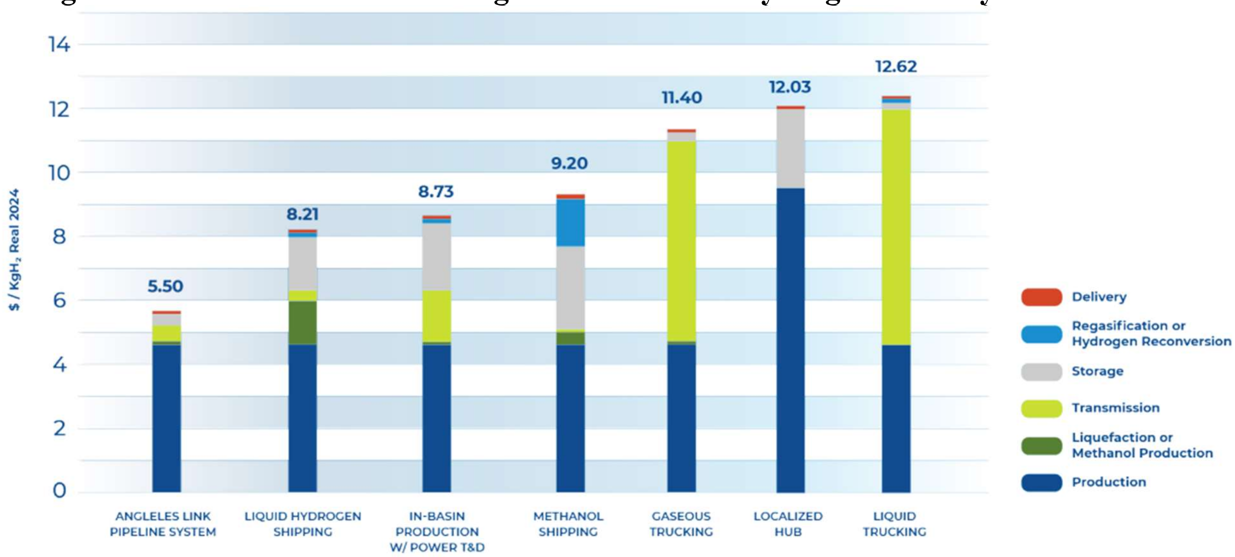
[30] Angeles Link Phase 1 Consolidated Report, SoCalGas, p. 20, available at: https://www.socalgas.com/sites/default/files/alproject/Angeles-Link-Phase-1-Consolidated-Report.pdf.
[31] Application of SoCalGas U 904 G, SoCalGas, December 20, 2024, available at: https://www.socalgas.com/sites/default/files/alproject/phase2/A.24-12-XXX_SoCalGasApplicationALP2_PDFA_2024.12.20.pdf.

SoCalGas's analysis has shown connective pipeline infrastructure like Angeles Link is the most cost-effective means to transport hydrogen volumes at scale. This analysis, performed in the ALP1 High Level Economic Analysis & Cost Effectiveness study,[32] compares the cost effectiveness of various hydrogen delivery options. Specifically, comparing pipeline delivery with various hydrogen delivery alternatives, such as trucking and power transmission and distribution (T&D) with in-basin production, hydrogen transported via Angeles Link is the most cost-effective means to deliver hydrogen into the Los Angeles Basin at scale. As depicted in Figure 2 below, Angeles Link can deliver hydrogen at a lower cost than the next most cost-effective hydrogen delivery alternative, liquid hydrogen shipping, which has high inherent costs due to liquefaction. The third most competitive hydrogen delivery alternative is power T&D with in-basin production. Please refer to the study for additional details.

Figure 2. Cost Effectiveness of Angeles Link versus Hydrogen Delivery Alternative[33]



The efficiency of pipeline transportation compares favorably to other infrastructure options. As CARB and E3 analyze alternative delivery modes, such as trucking, shipping, and alternative hydrogen carrier options, SoCalGas encourages analysis that considers the potential short-term and long-term interactions between different delivery modes, such as the potential role of trucking, depending on the timing and extent of pipeline infrastructure development. Understanding the economics of delivery alternatives and how they may be complementary will inform all stakeholders regarding the cost-effective delivery of hydrogen from production to end users.

2. *Are there examples of improvements in input efficiencies of the hydrogen production pathways discussed in this Workshop that should be reflected in the analysis of options for scaling production?*

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[32] Angeles Link Phase 1 High Level Economic Analysis & Cost Effectiveness Final Report, SoCalGas, December 2024, p. 16, available at: https://www.socalgas.com/sites/default/files/alproject/Angeles-Link-Phase-1-Final-High-Level-Economic-Analysis-&-Cost-Effectiveness.pdf.

[33] *Ibid.*, Angeles Link Phase 1 Consolidated Report, p. 9.

E3's presentation identified various hydrogen production pathways and illustrated that multiple supply options exist for cost-effective hydrogen to meet the demands identified in CARB's 2022 Scoping Plan. E3's analysis explored their estimated cost ranges and crucial affordability considerations.[34] Different technologies have unique factors that impact production volumes and scale. Together the diversity of clean renewable hydrogen supply options results in a more resilient energy ecosystem because it allows end-users to take advantage of production pathways where there is "strength in numbers." This diversity of supply options is likely to better support the faster transition to a decarbonized fuels economy.

As noted above, in the ALP1 Production Planning & Assessment SoCalGas assessed potential sources of third-party clean renewable hydrogen production from renewable supplies, including solar and wind, and identified three primary production areas within SoCalGas's service territory that could produce between 0.5 to 1.5 MMTPY of clean renewable hydrogen by 2045.[35] The study found that solar power paired with electrolyzers is a preferred production method due to its maturity, cost-effectiveness, and the abundance of solar irradiance in SoCalGas's service territory. The study found that various electrolytic technologies, including low-temperature Alkaline and Proton Exchange Membrane electrolyzers, as well as higher-temperature Solid Oxide electrolyzers, drive cost reductions associated with conversion efficiency and scale up. The study also acknowledged other pathways, such as hydrogen produced via biomass, that can similarly have an important and supporting role for clean renewable hydrogen production.

3. *Are there additional infrastructure needs or impacts that should be considered in the Analysis? If so, please describe.*

In addition to items discussed in Q4 below (e.g. permit streamlining), during Phase 1 of Angeles Link, SoCalGas identified and evaluated hydrogen delivery alternatives and non-hydrogen delivery alternatives in ALP1's Project Options and Alternatives Study. The analysis considered various factors such as state policy, ease of implementation, and scalability. It found that pipeline infrastructure like Angeles Link is a suitable and the most -cost-effective pathway for long-term large-scale delivery of hydrogen.[36] During the SB 1075 Technical Analysis Workshop, stakeholders expressed particular interest in the feasibility of transmitting electricity from remote solar facilities to urban demand centers for hydrogen production. This delivery alternative was also evaluated in the ALP1 Studies but not considered to be as cost effective[37] as this approach could require extensive and costly high-voltage transmission infrastructure.

A peer-reviewed study, *Cost of Long-Distance Energy Transmission by Different Carriers*, compares the costs of long-distance, large-scale energy transmission by electricity, gaseous, and

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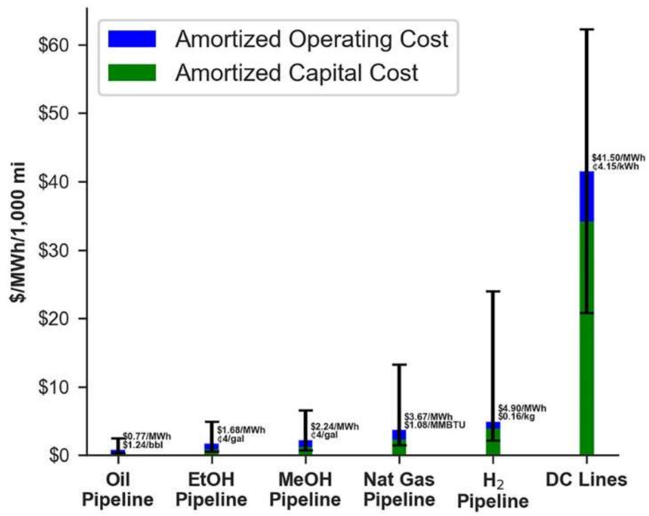
[34] *Ibid.*, E3 presentation, p. 15-16.
[35] Angeles Link Phase 1 Final Production Planning and Assessment, SoCalGas, December 2024, p. 2, available at: https://www.socalgas.com/sites/default/files/alproject/Angeles-Link-Phase-1-Final-Production-Planning-&-Assessment.pdf.
[36] Angeles Link Phase 1 Final Project Options and Alternatives, SoCalGas, December 2024, available at https://www.socalgas.com/sites/default/files/alproject/Angeles-Link-Phase-1-Final-Project-Options-&-Alternatives.pdf.
[37] Angeles Link Phase 1 High Level Economic Analysis & Cost Effectiveness Final Report, SoCalGas, December 2024, p. 16, available at: https://www.socalgas.com/sites/default/files/alproject/Angeles-Link-Phase-1-Final-High-Level-Economic-Analysis-&-Cost-Effectiveness.pdf.

liquid carriers (e-fuels). It finds that the costs per delivered megawatt hour (MWh) for DC electrical transmission lines can be up to eight times higher than those for hydrogen pipelines, eleven times higher than natural gas pipelines, and twenty to fifty times higher than liquid fuels pipelines (see Figure 3 below).[38] These cost differences are due to the lower carrying capacity of electrical transmission lines compared to pipelines. The paper emphasizes that these cost differences are significant and should be considered in renewable energy production and distribution analyses.

Figure 3: Amortized Transmission Costs per 1,000 miles[39]



4. *Is there any additional evidence or recent analysis that you would recommend for consideration in preparing this Analysis (e.g., recent white papers, public reports, data sources, policy recommendations developed for a different region, etc.)?*

<u>Angeles Link</u>

Through the ALP1 Studies process, SoCalGas has compiled a compendium of information on clean renewable hydrogen third-party production, transportation and end-use pathways as well as critical implications associated with each. In addition, the ALP2 Application and accompanied testimony outlines important topics, including policy, engineering, regulatory, and affordability considerations. SoCalGas believes this compendium of information can support the SB 1075 analysis to produce a comprehensive report that informs relevant stakeholders on the role of gas infrastructure to support California's climate plans.

<u>Hydrogen Blending</u>

SoCalGas commends CARB's continued recognition of hydrogen blends into the gas distribution system as a key demand source for hydrogen and recommends that CARB continue to explore

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[38] Cost of long-distance energy transmission by different carriers, DeSantis et al., Science Direct, December 21, 2021, available at: https://www.sciencedirect.com/science/article/pii/S2589004221014668#:~:text=The%20results%20indicate%20that%20the,than%20for%20liquid%20fuels%20pipelines.

[39] *Ibid.*, DeSantis et al.

hydrogen blending as a decarbonization and end use pathway via SB 1075 reporting. Blending hydrogen into existing gas distribution systems can help decarbonize existing end uses in the residential, commercial, and industrial sectors. Blending hydrogen into the existing infrastructure can also be a key tool to scale hydrogen production in the state, and in turn, drive down costs. A 20 percent hydrogen blend (by volume) across SoCalGas' total system equates to a demand of 1,400 tons of hydrogen per day (when keeping total delivered energy constant).[40] Blending hydrogen into the existing natural gas infrastructure can maximize an existing $15 billion asset to increase overall renewable fuel throughput across the state. One example of hydrogen blending occurring in another region is ATCO's Fort Saskatchewan Hydrogen Blending Project (ATCO Project), which is currently demonstrating successful blending up to 5 percent hydrogen into a subsection of the Fort Saskatchewan natural gas distribution system with plans to increase the blending to 20 percent.[41]

Common considerations when discussing hydrogen blending are impacts of NO_x emissions and operational compatibility of end use equipment. The *Hydrogen Blending Compendium Report* indicates general residential and commercial equipment show compatible operations with blends up to 20 percent. Recent research regarding NO_x (including but not limited to the *Hydrogen Blending Compendium Report*) suggests that hydrogen blending in common appliances, particularly with pre-mixed burner conditions, results in constant or reduced NO_x emissions compared to emissions with traditional natural gas.[42]

E3 indicates some end-use specific considerations for potential hydrogen blending, highlighting specific considerations for power generation with natural gas. Some of those considerations include potential for NO_x increases and potential equipment modification requirements. As E3 observed, however, in many cases existing turbines can be modified to accommodate higher hydrogen blend percentages, and this can be attained without increasing NO_x, and even potentially decreasing NO_x emissions. Additionally, the *Hydrogen Blending Compendium Report* indicates that generally, power plants can operate on up to 5 percent hydrogen blends in their existing configuration.[43] Regarding NO_x in power plants, the *Hydrogen Blending Compendium Report* notes the following, indicating that meeting existing NO_x limits is attainable:

> Although NO_x formation may be higher inside the turbine reaction chamber in the presence of hydrogen gas, the resulting NO_x output at the power plant flu stack must meet the same

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[40] Daily natural gas throughput: 2,416 MMCF/Day (2022)- per California Natural Gas Report: https://www.socalgas.com/sites/default/files/2024-08/2024-California-Gas-Report-Final.pdf
2,416 MMCF/day * 1,000 MCF/MMCF = 2,416,000 MCF/day
2,416,000 MCF *1,000 ft^3/MCF*1,029 BTU/FT^3 = 2,486,064,000,000 BTU
Ft^3 of Hydrogen = 0.2*(2,486,064,000,000 BTU/891.8 BTU/FT^3) = 557,538, 462 FT^3
HHV Blended Fuel = (0.2*343 BTU/FT^3)+((1-0.2)*1,029 BTU/FT^3) = 891.8 BTU/FT^3
H2 BTU = 557,538, 462 FT^3 * 343 BTU/FT^3 = 191,235, 692,308 BTU
H2 KG = 191,235, 692,308 BTU * (1 kJ/0.947817 BTU) * (1 MJ/1,000 kJ) * (1 kg/ 141.8 MJ [H2 HHV]) = 1,422,880 kg Tons H2 = 1,422,880 KG * (1 Metric Ton/1,000kg) = 1,423 Metric Tons

[41] ATCO, Fort Saskatchewan Hydrogen Blending Project, available at: https://gas.atco.com/en-ca/community/projects/fort-saskatchewan-hydrogen-blending-project.html.

[42] Impact of Hydrogen/Natural Gas Blends on Partially Premixed Combustion Equipment: NOx Emission and Operational Performance; California Energy Commission, October 2020, available at: https://www.energy.ca.gov/sites/default/files/2021-05/CEC-500-2020-070.pdf.

[43] *Ibid.*, Hydrogen Blending Compendium Report, Chapter Summary, p.14.

permitted limits as power plants operating at 100 percent natural gas. Meeting these limits is possible due to various NO_x control technologies that reduce the formation of NO_x altogether in the combustion chamber or remove it at the flu stack. With the proper deployment of these technologies, blended hydrogen combustion via turbines can achieve comparable performance and NO_x emissions equal to or even less than today's turbines running on pure natural gas.[44]

Environmental Permitting

E3's presentation highlighted permitting requirements that may be relevant to hydrogen production projects, while noting that permitting requirements will vary across pathways and for specific sites. While not specifically mentioned in E3's presentation, SoCalGas notes that permit streamlining is crucial to enable California to decarbonize the economy. CARB has also noted in its[45] that delays in permitting and siting of renewable generation put the state at risk of failing to meet its goals, and that policy interventions can reduce the risk of delays.[46]

Compendium of Hydrogen Studies

SoCalGas suggests the following additional third-party studies to CARB and E3 for reference in their SB 1075 analysis that could provide valuable insights for data validation and assumption development.

- *Pathways to Commercial Liftoff: Clean Hydrogen*[47] by U.S. DOE. This study assesses the requirements to accelerate the deployment of clean hydrogen at scale. It identifies key market enablers, investment opportunities, and potential bottlenecks across the hydrogen value chain. The report focuses on the financial and policy mechanisms needed to drive cost reductions, expand infrastructure, and support hydrogen adoption in hard-to-abate sectors.

- *Hydrogen: Closing the Cost Gap: Unlocking Demand for Clean Hydrogen by 2030*[48] by the Hydrogen Council. This report provides a detailed analysis of the cost trajectory for low-carbon hydrogen and the factors influencing its competitiveness with conventional fuels. It explores key cost drivers such as renewable energy prices, electrolyzer efficiencies, infrastructure costs, and scaling effects. In addition to cost reduction pathways, the report assesses demand growth across sectors, regional variations in

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[44] *Ibid.*, Hydrogen Blending Compendium Report, Chapter Summary, p.14.

[45] CARB 2022 Scoping Plan, Appendix J, available at: https://ww2.arb.ca.gov/sites/default/files/2022-11/2022-sp-appendix-j-uncertainty-analysis.pdf.

[46] For clarity, SoCalGas also notes that certain of the permits and approvals referenced in E3's presentation may not be required for all hydrogen production projects. For example, New Source Review (NSR) is only required for facilities that are "major sources" subject to Title V of the Clean Air Act. For production pathways like electrolytic hydrogen, the production process would not be considered a major source and therefore is not subject to Title V. E3 also references the time to obtain incidental take permits under the California and/or federal Endangered Species Acts, but such permits may not be required for all hydrogen projects and would be location specific.

[47] Pathways to Commercial Liftoff: Clean Hydrogen, U.S. DOE, December 2024, available at: https://liftoff.energy.gov/wp-content/uploads/2025/01/LIFTOFF_Clean-Hydrogen-2024-Update_Updated-2.6.25.pdf.

[48] Hydrogen: Closing the Cost Gap: Unlocking demand for clean hydrogen by 2030, Hydrogen Council, March 2025, available at: https://hydrogencouncil.com/en/hydrogen-closing-the-cost-gap/.

hydrogen adoption, and the role of policy incentives to enable large-scale market deployment.

- *Harnessing Hydrogen: A Key Element of the U.S. Energy Future*[49] by the National Petroleum Council. This study highlights the role of low-carbon intensity (LCI) hydrogen in achieving U.S. net-zero emissions goals. It also outlines a comprehensive roadmap for hydrogen deployment in the U.S. energy system and examines its potential in reducing emissions across multiple sectors, including industry, transportation, and power generation. Additionally, the study addresses infrastructure challenges, policy and regulatory considerations, and the economic feasibility of different hydrogen production pathways.

- *Scattergood Modernization Project Alternative: Summary of Findings*[50] by National Renewable Energy Laboratory. This study evaluates the LADWP's plan to replace two aging generators at the Scattergood Generation Station with a new 330 MW combined-cycle gas turbine power plant, capable of burning natural gas and hydrogen. Known as the Scattergood Modernization Project (SMP), this initiative aims to address the retiring capacity by 2029. The study compares SMP to non-combustion alternatives such as fuel cells, energy storage, demand response, and new transmission. It concludes that these alternatives are not viable due to challenges like insufficient space, high costs, and technology risks. Updating the original LA100 analysis, the study reaffirms that renewably fueled combustion turbines are likely the lowest-cost and the lowest-risk option for reliable dispatchable capacity at Scattergood in the 2030 timeframe.

- *Unlocking California's Climate Ambition*[51] by the Boston Consulting Group (BCG). This study is a collaborative effort led by BCG with support from California's major Investor-Owned Utilities (SCE, SDG&E, PG&E, and SoCalGas). The study emphasizes the critical role of electric and gas utilities to help unlock California's climate ambitions. The BCG report emphasizes the importance of developing of an integrated statewide plan to include both molecules and electrons in the energy transition; eliminating permitting, investment, and procurement bottlenecks to accelerate infrastructure development; and leveraging innovative funding mechanisms to equitably fund the energy transition. Without urgent reforms, delays and cost burdens could jeopardize the state's 2045 carbon neutrality goal.

Conclusion

SoCalGas appreciates the invitation to engage in the development of the SB 1075 report. The recognition by CARB and E3 that hydrogen is crucial to attaining California's AB 1279 goals is promising. Affordability is critical to decarbonization**.** Meaningful progress demands that we strategically leverage both existing and new infrastructure as vital complements to our gas and

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[49] Harnessing Hydrogen: A Key Element of the U.S. Energy Future, National Petroleum Council, 2024, available at: https://harnessinghydrogen.npc.org/downloads.php.

[50] Scattergood Modernization Project Alternatives: Summary of Findings, National Renewable Energy Laboratory, 2025, available at: https://www.ladwp.com/sites/default/files/2025-03/Scattergood Moderniazation Alternative Study Final.pdf.

[51] Unlocking California's Climate Ambition, Boston Consulting Group (BCG), July 2024, available at: https://www.bcg.com/publications/2024/united-states-unlocking-californias-climate-ambition

electric systems. Underground assets like pipelines offer a powerful solution. They are not only cost-effective but also resilient in the face of extreme weather and increasingly frequent natural disasters. By embracing these proven, practical tools, we can drive decarbonization without sacrificing reliability or escalating costs.

Utility-owned and operated pipelines have great attributes that will help them play a key role in the hydrogen economy: (1) Utilities have decades of experience designing, constructing, maintaining, and operating pipeline systems; (2) Pipelines are open access and dedicated to public use; and (3) Utilities can promote customer affordability by leveraging the value and service of the gas pipeline system and supplementing it with hydrogen blending and Angeles Link. CARB can facilitate affordable decarbonization by sending policy signals that address uncertainties, risks, and other long-term scenario planning considerations. This approach will foster integrated energy infrastructure planning. Thank you for your consideration of our comments.

Respectfully,

/s/ Kevin Barker

Kevin Barker
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